

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A ~~computer-implemented database management system that manages a database including a database data page, the database data page providing sub-page storage space, the database management system further managing a plurality of concurrent database transactions, each of the concurrent database transactions requiring a modification of the database data page and storing a respective copy of the database data page in a separate reserved space, the database management system~~ comprising:

a processor; and

one or more physical computer readable storage media operatively coupled to the processor, the computer-readable storage media having stored thereon computer executable instructions that, when executed by the processor, implement the database management system, including:

a ~~computer-implemented database engine that that employs a page aggregator component to facilitate operations of the concurrent database transactions at a sub-page level during modification of the database data page, the database engine further~~ comprising:

a lock manager that enables sub-page level locking across the concurrent database transactions and that stores lock information, sub-page level locking grants one of the concurrent database transactions an exclusive lock on a first sub-page of the database data page when the one of the concurrent database transactions requests to modify the first sub-page, the exclusive lock permits the one of the concurrent database transactions to modify a copy of the first sub-page in its respective copy of the database data page while restricting others of the concurrent database transactions from modifying corresponding copies of the first sub-page in their respective copies of the database data page, but allows the others of the concurrent database transactions to modify other sub-pages.

a ~~computer-implemented~~ page aggregator component that operates across the concurrent database transactions to obtain information on an aggregate size change that occurs on [[a]]the database data page that results when the concurrent database transactions modify their respective copies of the database data page using sub-page

level operations, the page aggregator operates across the concurrent database transactions by using the lock information in the lock manager to track the sub-page level operations performed by the concurrent database transactions; and wherein a number of copies of the database data page are created and data associated with the database data page is modified by the concurrent database transactions performed on respective copies of the database data page resulting in the aggregate size change to the database data page, the concurrent database transactions perform sub-page level operations on the respective copies of the database data page;

a computer-implemented heap allocation component that employs the information on the aggregate size change to determine a space consumed on the database data page and a space available on the database data page to ensure that the plurality of concurrent multiple database transactions do not consume all of the storage space on the database data page, availability of space for the database data page; and

a computer-implemented lock manager that enables sub-page level locking across the concurrent database transactions.

2-4. (Cancelled)

5. (Currently Amended) The database management system of claim 1, the ~~computer-implemented~~ page aggregator component enables determination of space consumption across a respective copy of the database data page employed by each concurrent database transaction.

6-8. (Cancelled)

9. (Currently Amended) The database management system of claim 1, the ~~computer-implemented~~ heap allocation component and the ~~computer-implemented~~ page aggregator component enforce a set of conditions on a database transaction that operates on the database data page, such that space availability for the database data page prior to the commit stage of the database transaction is assured.

10-12. (Cancelled)

13. (Currently Amended) In a database management system that manages a database including a database data page, the database data page providing sub-page row storage space, the database management system further managing a plurality of concurrent database transactions, each of the concurrent database transactions requiring a modification of the database data page, A computer-implemented method that facilitates synchronization [[in]]of the concurrent database transactions comprising:

creating a number of copies of [[a]]the database data page for each of the corresponding to a number of the concurrent database transactions, each of the concurrent database transactions storing its respective copy of the database data page in a separate reserved space to facilitate modifying the database data page;

assigning a plurality of exclusive row level locks to the concurrent database transactions, the exclusive row level locks granting each of the concurrent database transactions exclusive permission to modify a different row in their respective copies of the database data page;

storing information related to the exclusive row level locks;

performing each of the concurrent database transactions modifying their respective copies of the database data page [[on a]]using sub-page row level operations on the respective copies of the database data page to modify the respective copies of the database data page to facilitate modifying the database data page;

obtaining information on an aggregate size change that occurs on the database data page as a result of the row level operations performed on each of the respective copies of the database data page by the concurrent database transactions performed on the respective copies of the database data page, the information obtained at least in part by using the information related to the exclusive row level locks;[[and]]

tracking a space consumed on the database data page and a space availability available [[for]]on the database data page over all the concurrent database transactions[.]; and

ensuring that the concurrent database transactions do not consume all of storage space on the database data page based in part on the tracked space availability.

14-15. (Cancelled)

16. (Currently Amended) The method of claim 13 further comprising replacing a row of the database data page with ~~an inserting~~ a pointer to a row of a new database data page to guide a query to the row in the new database data page.

17. (Currently Amended) The method of claim 16 further comprising inserting the row on ~~[[a]]~~ the new database data page.

18. (Cancelled)

19. (Currently Amended) The method of claim ~~[[18]]~~ 13 further comprising discarding ~~[[the]]~~ a row lock ~~[[locks]]~~ upon at least one of a roll back of a database transaction or committing a database transaction.

20. (Cancelled)

21. (Currently Amended) A computer program product comprising one or more physical computer readable storage media having stored thereon computer executable instructions that, when executed by a processor, perform the method of claim 13.~~A computer-readable medium having stored thereon computer executable instructions for carrying out the method of claim 13.~~

22-36. (Cancelled)

37. (Currently Amended) The method of claim [[32]]13 further comprising assuring availability of space on the database data page prior to a commit stage of the concurrent database transactions operating on the database data page to mitigate reorganization of data around the database data page at the commit stage.